

(19) World Intellectual Property Organization
International Bureau



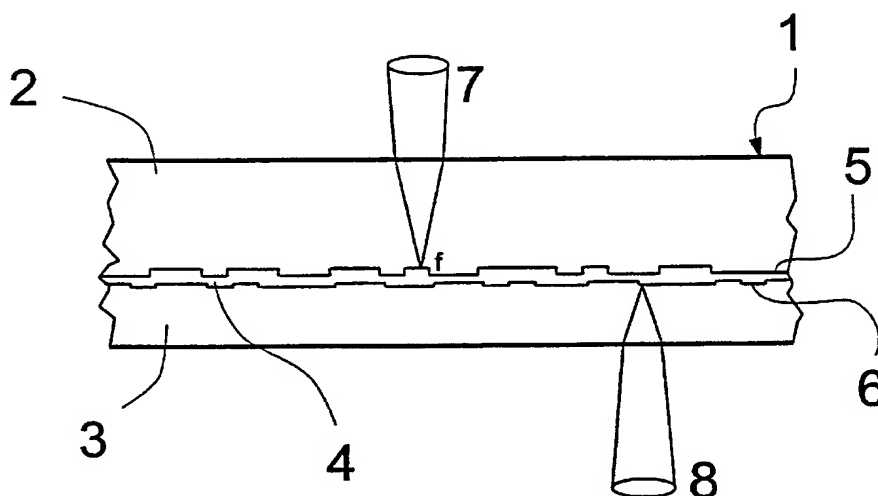
(43) International Publication Date
15 February 2001 (15.02.2001)

PCT

(10) International Publication Number
WO 01/11617 A1

- (51) International Patent Classification⁷: **G11B 7/24, 7/26**
- (21) International Application Number: **PCT/DK00/00435**
- (22) International Filing Date: **4 August 2000 (04.08.2000)**
- (25) Filing Language: **English**
- (26) Publication Language: **English**
- (30) Priority Data:
PA 1999 01096 5 August 1999 (05.08.1999) **DK**
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- (81) Designated States (national): **AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.**
- (84) Designated States (regional): **ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).**
- Published:**
— *With international search report.*
- For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

(54) Title: **COMBINED COMPACT DISC/DIGITAL VERSATILE DISC PRODUCT**



(57) Abstract: Two-side storage medium (1) formed of a first substrate (2) and a second substrate (3), each having embedded data-carrying layers for optical reading, e.g. by means of a laser beam (7, 8), from either side of the storage medium (1), where the density of the first data-carrying layer (5) of the storage medium (1) differs from the density of the second data-carrying layer (6) of the storage medium (1). The thickness of the first substrate (2) ranges between 1.1 and 1.3 mm, while the thickness of the second substrate (3) ranges between 0.5 and 0.7 mm. As a result a storage medium which can be read by the most common devices adapted for reading storage media in one or more of the standard type formats corresponding to the format of the data layers, the thickness of the first substrate corresponding to the thickness of conventional storage media with only one layer. No adjustment of the read head, which effects reading from below, is thus needed. A superjacent layer does not impede the said reading. Consequently, the problems with correctly focussing the scanning laser beams on the data-carrying layer in the first substrate are no longer present.



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Title: Combined compact disc/digital versatile disc product.

Technical Field

The invention relates to a two-sided storage medium formed of a first substrate and
5 a second substrate, each having encoded, reflective data-carrying layers for optical
reading, eg by means of a laser beam, from at least one side of the storage medium,
where the density of the first data-carrying layer of the storage medium differs from
the density of the second data-carrying layer of the storage medium.

Background Art

10 It has been known for some time to optically store digital information, eg on a com-
pact disc (CD). Well-established standards exist regarding dimensions, materials,
data density and coding formats for such compact discs, both for audio and data
purposes. In recent years a new format has come on the market, viz. the so-called
Digital Versatile Disc-format, abbreviated to DVD. This format is advantageous in
15 that far more information per area unit can be stored than on a CD, said information
being stored with a higher density, and further in that the playback devices developed
for the DVD format are able to read the information at a higher velocity than in the
CD format. As a result it is possible in practice to store for instance an entire feature
film on a single DVD. DVD types have also been developed which can store infor-
20 mation on both sides of the storage medium and other types storing information in
multiple layers on one side of the storage medium.

The known CD format typically uses a one-sided storage medium of plastic having
an outer diameter of 12 centimetres (even though other diameter sizes occur), a
thickness of about 1.2 mm and an accurately centered centre hole having a diameter
25 of about 15 mm. Devices for playback of the CD format are carefully adapted to the
standardised dimensions - irrespective of whether it is a digitally encoded audio

signal (music CDs) or software for various types of computers (CD-ROMs). The plastic material used is typically polycarbonate (PC). A compact disc is conventionally made by forming a predetermined pattern of depressions (pits) into one side of a plastic disc during production thereof, and subsequently vapour-depositing a thin reflective metal layer on top of the groove pattern formed. The finished CD is then coated with a protective lacquer layer, on which for instance text information about the content may be offset printed.

WO 98/38637 discloses a two-sided storage medium formed of a DVD having half the thickness of conventional DVDs, and a CD (in the following referred to as a CD-O (Compact Disc -Only)) of half the thickness of a conventional CD-O, in which each of two substrates of the storage medium contains data-carrying layers for optical reading thereof, eg. by means of a laser beam, said data layers both containing the same information in two different data formats, which inter alia differs from one another in the density of the two data-carrying layers. The two substrates may for instance be bonded by means of an adhesive. However the above two-sided storage medium is encumbered by the serious drawback that a specially designed reader is required to reproduce the stored information from both sides of the storage medium. This is probably due to the thickness of the individual layer of the storage medium only being half the thickness of conventional storage media of the DVD or CD-O type. Conventional storage media of the CD-O type normally have a thickness of about 1.2 mm and the laser used in conventional devices for reading storage media of the CD-O type are therefore adapted to focus the laser beam on the data-carrying layer within a very limited area. The refractive index of the transparent base, usually polycarbonate, which is the main component of the storage medium, is constant. The refractive index is thus a decisive parameter when determining the focal area of the scanning laser beam perpendicular to the data layer. Consequently a storage medium of the CD-O type of a smaller thickness cannot be read by such devices, the laser beam being unable to focus on the data-carrying layer and focussing instead on a point on the other side thereof. Thus a storage medium of this kind requires a spe-

cially designed device in order to reproduce the information stored, whereby one of the benefits of storing information in two formats on one storage medium is lost. Practical tests have in fact shown that a two-sided storage medium of the type disclosed in WO 98/38637 cannot be read by means of conventional readers and that
5 specially designed devices are required for this purpose.

Brief Description of the Invention

The object of the invention is to provide a storage medium with two separate data layers, each layer being thicker than conventional storage media of the DVD or CD-O type, and readable by the most common reader devices for conventional DVD
10 or CD-O storage media.

The invention is based on the idea that it should be possible to read a storage medium of an increased total thickness than hitherto known by means of a conventional reader device so as to eliminate the problems with focussing the scanning laser beam correctly on the data layer to be read.

15 According to the invention a two-sided storage medium of the above type is characterised in that the thickness of the first substrate, preferably the lowermost substrate, ranges between 1.1 mm and 1.3 mm, preferably about 1.2 mm, and that the thickness of the second substrate, preferably the uppermost substrate, ranges between 0.5 mm and 0.7 mm, preferably about 0.6 mm. As a result a storage medium is obtained
20 which is readable by the most common devices adapted for reading storage media in one or more of the standard type formats corresponding to the format of the data layers, while the feature of the thickness of the first substrate corresponding to the thickness of conventional storage media with only one layer is utilized. No adjustment of the read head, which effects reading from below, is thus needed. Furthermore
25 more it has been found that a superjacent layer does not impede such a reading. Consequently, the problems with correctly focussing the scanning laser beams on the

data-carrying layer in the first substrate are no longer present.

Further according to the invention the first data-carrying layer of the first substrate of the storage medium may have a density in excess of about $0.4 \mu\text{m}^2/\text{channel bit}$, and the second data-carrying layer of the second substrate of the storage medium may have a density of less than about $0.12 \mu\text{m}^2/\text{channel bit}$. This results in a complete storage medium, which for instance may contain data in a CD format in the first data-carrying layer and data in a DVD format in the second data-carrying layer. The data layer in the first substrate, ie the CD substrate, may furthermore preferably represent an audio signal, while the data layer in the second substrate, ie the DVD substrate, may preferably represent a video signal.

Moreover according to the invention one of the data-carrying layers may be of the Compact-Disc-Only (CD-O) type, while the other data-carrying layer may be of the Digital Versatile Disc-5 (DVD-5) type. As a result a storage medium which is readable by existing devices is obtained.

Furthermore according to the invention the two substrates of the storage medium may be bonded, preferably by means of an adhesive, preferably a lacquer, which furthermore may be UV-curable, and distributed between the two substrates of the storage medium, resulting in a simplified sequence of operation during production of the storage medium, existing devices and materials being used for the production and a well-known solid bonding type which inter alia ensures that the two substrates of the finished storage medium are correctly centered.

Moreover according to the invention the total thickness of the two-sided storage medium (1) may range from 1.6 mm to 2.0 mm, preferably from 1.7 mm to 1.9 mm. As a result a storage medium is obtained which can read by most conventional reader devices for the DVD or CD-O storage media, eg DVD or CD-O readers in personal computers, DVD players for playback of feature films and CD-O players for play-

back of audio CDs in stationary or portable stereo sets. However, the increased thickness prevents certain special readers, eg CD-O or DVD readers in portable personal computers or audio CD players for cars from reproducing the stored information. Such readers are adapted to storage media with the common thickness of about 1.2 mm, and the storage medium according to the invention thus cannot be read by the substrate of the reader adapted to automatically grip and receive a storage medium for placing this correctly in relation to the drive means and laser reading units of the reader.

According to the invention the data-carrying layer of the first substrate of the storage medium having a density in excess of about $0.4 \mu\text{m}^2/\text{channel bit}$ may be adapted to be read by a device, which is able to read conventional compact discs (CD-O), and the data-carrying layer of the second substrate of the storage medium having a density of less than about $0.12 \mu\text{m}^2/\text{channel bit}$ may be adapted to be read by a device, which is able to read conventional Digital Versatile Disc-5-discs (DVD). The data layers of the storage medium may furthermore be adapted to be read by a device which is able to read both conventional compact discs CD-O) and Digital Versatile Disc-5-discs (DVD-5). A highly flexible storage medium is thus obtained, which for instance may have data representing audio signals stored on one side and data representing video signal with associated audio signals on the other side.

The invention further relates to a method of producing a two-sided storage medium, said method being characterised in that the two substrates of the storage medium are made separately and subsequently bonded together, preferably by means of an adhesive. A storage medium which is simple and inexpensive to manufacture is thus obtained, the two data-carrying layers being quality-controlled separately prior to bonding thereof, whereby any waste due to errors in one of data layers is minimised.

Furthermore, according to the invention the used adhesive may be a lacquer, preferably a liquid lacquer of a type, which can be cured at exposure to ultra-violet light,

whereby existing method of producing conventional CD-O discs and DVD discs may be used.

According to the invention the used lacquer may be an acrylic lacquer.

Finally according to the invention the first substrate of the storage medium may be coated with a liquid lacquer layer, whereafter the second substrate of the storage medium is placed on top of the first substrate, the data-carrying layers facing each other and the liquid lacquer layer being present between the two substrates, whereafter the storage medium is rotated in such a manner that excess lacquer is spun out of the space between the two substrates such that this rotation ensures that the thickness of the lacquer layer is reduced to between about 0.04 mm and 0.07 mm, preferably to between about 0.05 mm and 0.06 mm, and the remaining lacquer layer between the two substrates in the end are cured, preferably by exposure to UV-light. Existing production and quality control devices may be utilised in this method and it is ensured the air bubbles or impurities are not trapped between the two substrates of the storage medium during this production step.

A two-sided storage medium is thus obtained, which is easy to produce by means of existing production equipment and which contains different information in the two data-carrying layers and which can be read from either side by conventional reader devices for storage media of the CD-O type and/or the DVD type.

20 Brief Description of the Drawings

The invention is described in greater detail below with reference to the accompanying drawings, in which

Fig. 1 is a sectional view of a two-sided storage medium according to prior art,

Fig. 2 is a sectional view of a two-sided storage medium according to the invention, and

Fig. 3 is diagrammatic, exploded perspective view of a two-sided storage medium according to the invention.

5 Best Mode for Carrying Out the Invention

The two-sided storage medium 1 according to prior art shown in Fig. 1 contains two data-carrying layers 5,6, which are readable from either side of the storage medium 1 by means laser reading units 7 or 8. These reading units 7 or 8 are usually arranged side by side in a common housing (not shown) and are arranged on either respective
10 side of the storage medium 1 in Fig. 1 to illustrate the principle. The first data-carrying layer 5 representing audio information in a CD-O format is protected by a transparent plastic layer 2, preferably of polycarbonate, of a thickness of about 0.6 mm. The second data-carrying layer 6 representing video and audio information in a DVD format is likewise protected by a corresponding plastic layer 3, also of a thickness
15 of about 0.6 mm. The two data-carrying layers 5,6 are bonded together, eg by adhesion, the two layers facing each other. The plastic layer 2, which forms substrate of the optical system and further comprises the laser reader unit 7 with associated focusing system and the second data-carrying layer 5, has a refractive index depending on the material used and is a determining factor for the focal point f' of the reader
20 unit 7 in the relevant substrate of the storage medium 1. The optical system in conventional reader devices available on the market today are adapted to a thickness of the transparent plastic layer 2 of about 1.2 mm. Since the space between the lens system of the reader unit 7 and the outer surface of the transparent plastic layer 2 always is the same, the storage medium 1 substantially being read from the lower
25 face, and since the storage medium thus rests on a rotating disc in the device, the focal point f' is only in the same plane as the data-carrying layer 5, if the plastic layer 2 has the correct thickness of about 1.2 mm. In two-sided storage media ac-

According to prior art the plastic layer 2 is only half as thick, ie 0.6 mm. Thus, the focal point f' cannot be in the same plane as the data-carrying layer 5, when it is attempted to read the relevant side of the storage medium 1 by means of devices adapted to read this type data, whereby the device is unable to decode the stored data correctly.

The storage medium 1 according to the invention shown in Fig. 2 comprises two data-carrying layers 5,6, which are readable from either side of the storage medium 1 by means of a laser reader means 7 or 8 depending on which of the sides of the storage medium 1 is to be read. The first data-carrying layer 5 representing audio information in a CD-O format is protected by a transparent plastic layer 2, preferably of polycarbonate, having a thickness of about 1.2 mm. The second data-carrying layer 6 representing video and audio information in a DVD format is protected by a corresponding plastic layer 3, the only difference being that the thickness of the plastic layer is about 0.6 mm. The two data-carrying layers are bonded together with an intermediate bonding layer 4, preferably a transparent, UV-curable lacquer. The data-carrying layers are produced such that the information is provided on either side of the plastic layers 5,6 in an injection moulding process and subsequently metallised by vacuum to provide a reflective surface, which is able to reflect the light from the laser reader means 7 or 8 in a well-defined manner depending on the pattern formed in the plastic layers 5, 6. The reader unit 7, which is shown diagrammatically in Fig. 2, is able to focus a laser beam in a point f in the same perpendicular plane as the data-carrying layer 5. The reader unit 8 is able to read the other side of the storage medium 1 in a similar manner when the medium is turned over.

A diagrammatic view of a two-sided storage medium 1 according to the invention is shown in Fig. 3. The first substrate 2 of the storage medium 1 is provided with information on the side facing upwards in Fig. 3. The information 5 is metallised to provide the desired reflectivity. The said side of the first substrate 2 is coated with a layer 4 of liquid adhesive, eg a UV lacquer, which subsequently is distributed

evenly on the surface of substrate 2 facing upwards. A second substrate 3 of the storage medium 1 is encoded with another type of information 6 on the side facing downwards in Fig. 3. The said information is also metallised to provide the desired reflectivity. The substrate 3 is then made to abut the evenly distributed layer 4 of liquid adhesive on the substrate 2 of the storage medium 1 such that the adhesive layer 4 is present between the two metallised information-carrying layers 5,6 of the substrates 2,3. The two substrates are carefully centered in such a manner that excess adhesive is spun out of the space between the two substrates 2,3, whereby the distance between the two information-carrying layers is reduced to a thickness of about 0.55 mm.

Thus, a storage medium is provided in an inexpensive and simple manner, said medium being readable by most existing devices for reading storage media of the CD-O or DVD type. With a few modifications, the storage medium may furthermore be produced by means of existing production equipment for producing CD-Os and DVDs.

A small number of existing devices are not able to read the storage medium according to the invention. These devices are primarily used in music systems in cars, portable computers and certain types of portable CD players, which due to a thickness of about 2 mm of the storage medium, have no space for receiving and placing the storage medium according to the invention in the playback means of said devices.

Claims.

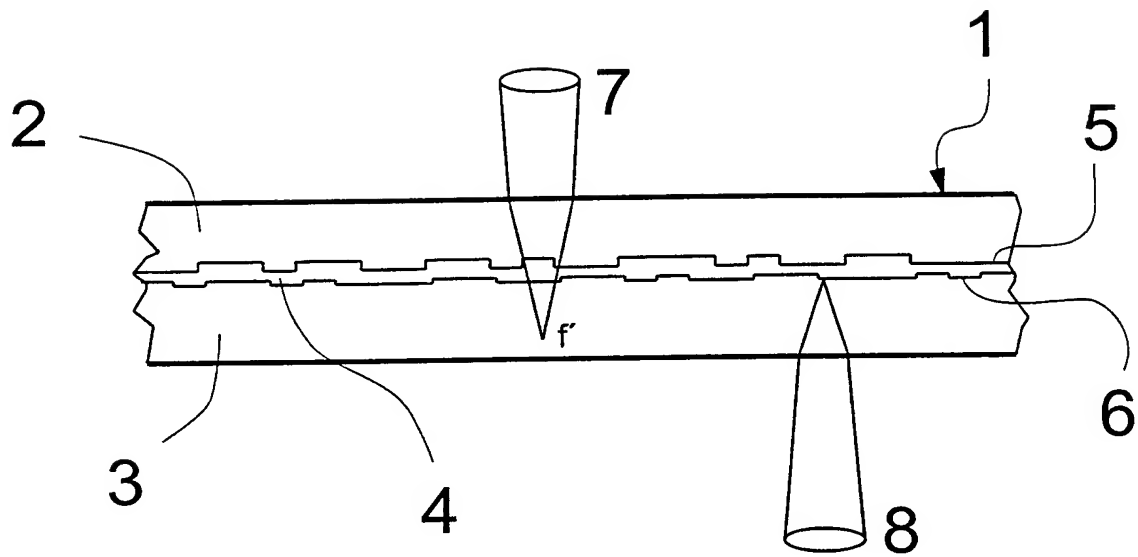
1. Two-side storage medium (1) formed of a first substrate (2) and a second substrate (3), each having encoded data-carrying layers for optical reading, eg by means of a laser beam (7, 8), from either side of the storage medium (1), where the density of the first data-carrying layer (5) of the storage medium (1) differs from the density of the second data-carrying layer (6) of the storage medium (1), characterised in that the thickness of the first substrate (2) ranges between 1.1 mm and 1.3 mm, preferably about 1.2 mm, and that the thickness of the second substrate ranges between 0.5 mm and 0.7 mm, preferably about 0.6 mm.
2. Storage medium (1) according to claim 1, characterised in that the first data-carrying layer (5) of the first substrate (2) of the storage medium (1) has a density in excess of about $0.4\mu\text{m}^2/\text{channel bit}$, and the second data-carrying layer (6) of the second substrate (3) of the storage medium (1) has a density of less than about $0.12\mu\text{m}^2/\text{channel bit}$.
3. Storage medium (1) according to claim 1 or 2, characterised in that the first data-carrying layer (5) is of the Compact Disc-Only (CD-O) type, said first data-carrying layer (5) preferably representing an audio signal, and that the second data-carrying layer (6) is of the Digital Versatile Disc-5 (DVD-5) type, said second data-carrying layer (6) preferably representing a video and an audio signal.
4. Storage medium (1) according to claims 1 to 3, characterised in that the two substrates (2, 3) of the storage medium (1) are bonded, preferably by means of an adhesive (4), preferably a lacquer, which furthermore may be UV-curable, and distributed between the two substrates (2,3) of the storage medium (1).
5. Storage medium (1) according to claims 1 to 4, characterised in that the total thickness of the two-sided storage medium (1) ranges from 1.6 mm to 2.0

mm, preferably from 1.7 mm to 1.9 mm.

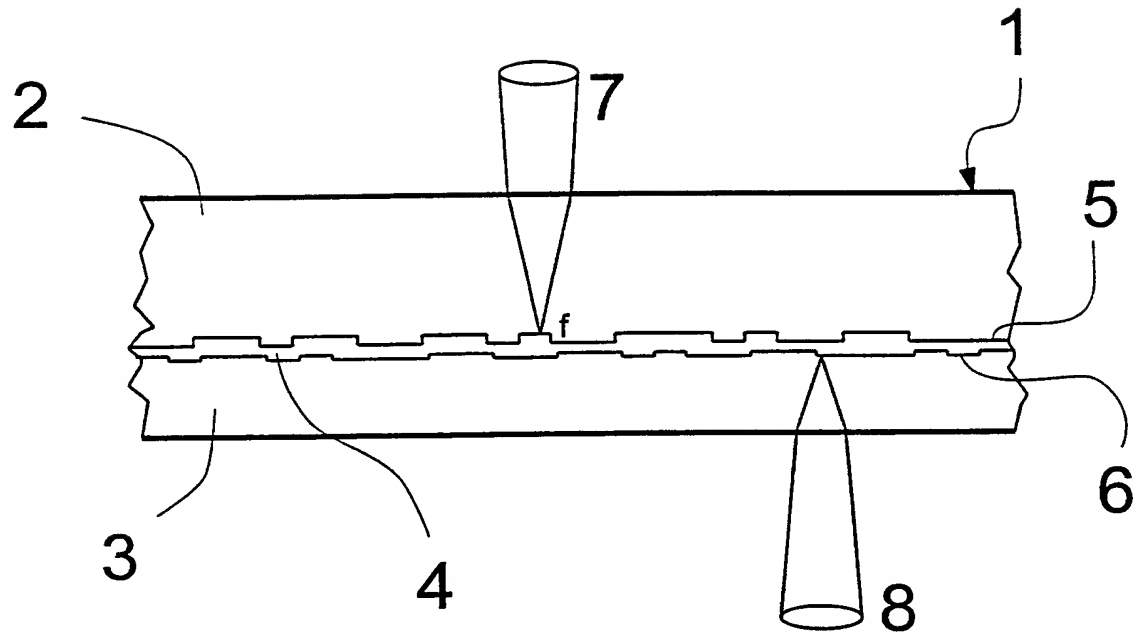
6. Storage medium (1) according to one or more of the preceding claims,
c h a r a c t e r i s e d in that the data-carrying layer (5) of one substrate (2) of the
storage medium (1) having a density exceeding about $0.4\mu\text{m}^2/\text{channel bit}$ is adapted
5 to be read by a device which is able to read conventional compact discs (CD-O).
7. Storage medium (1) according to one or more of the preceding claims,
c h a r a c t e r i s e d in that the data-carrying layer (6) of the second substrate (3)
of the storage medium (1) having density of less than about $0.12\mu\text{m}^2/\text{channel bit}$ is
adapted to be read by a device which is able to read conventional Digital Versatile
10 Disc-5-discs (DVD).
8. Storage medium (1) according to one or more of the preceding claims,
c h a r a c t e r i s e d in that the data layers (5, 6) of the storage medium (1) is
adapted to be read by a device which is able to read both conventional compact discs
(CD-O) and Digital Versatile Disc-5-discs (DVD-5).
- 15 9. Method of producing a two-sided storage medium (1) according to one or more
of the claims 1-8, c h a r a c t e r i s e d in that the two substrates (2, 3) of the
storage medium (1) are made separately and subsequently bonded together, prefera-
bly by means of an adhesive (4).
10. Method of producing a two-sided storage medium (1) according to claim 9,
20 c h a r a c t e r i s e d in that the used adhesive (4) is a lacquer, preferably a liquid
lacquer of a type which can be cured at exposure to ultra-violet light.
11. Method of producing a two-sided storage medium (1) according to claim 10,
c h a r a c t e r i s e d in that the lacquer used is an acrylic lacquer.

12. Method of producing a storage medium (1) with two substrates (2,3) according to claim 1, characterised in that the first substrate (2) of the storage medium (1) is coated with a liquid lacquer layer (4) and the second substrate (3) of the storage medium (1) subsequently is placed on top of the first substrate (2), the data-carrying
5 layers (5,6) facing each other and the liquid lacquer layer (4) being present between the two substrates (2,3), whereafter the storage medium (1) is rotated in such a manner that excess lacquer is spun out of the space between the two substrates such that this rotation ensures that the thickness of the lacquer layer is reduced to between about 0.04 mm and 0.07 mm, preferably to between about 0.05 mm and 0.06 mm,
10 and the remaining lacquer layer (4) between the two substrates (2,3) in the end are cured, preferably by exposure to UV-light.

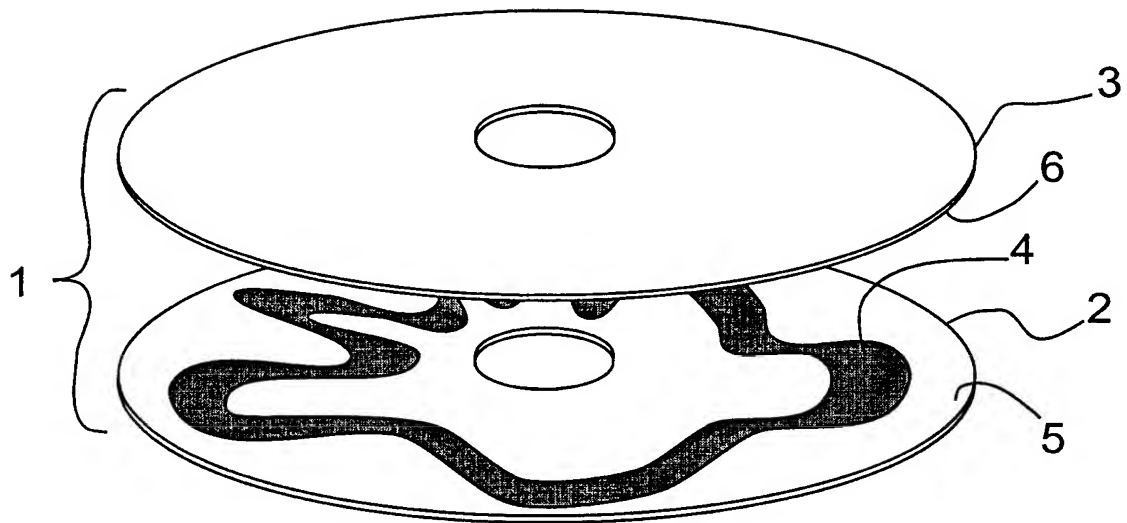
1/3

**Fig. 1**

2/3

**Fig. 2**

3/3

***Fig. 3***

INTERNATIONAL SEARCH REPORT

International application No.

PCT/DK 00/00435

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: G11B 7/24, G11B 7/26

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: G11B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 9838637 A1 (WEA MANUFACTURING, INC.), 3 Sept 1998 (03.09.98), page 1, line 12 - page 2, line 13; page 4, line 27 - page 6, line 21, cited in the description	1-3,5-7,9
Y	--	4,8
X	EP 0706178 A2 (MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.), 10 April 1996 (10.04.96), column 10, line 44 - column 12, line 26, figures 3A-3D	9-12
Y	--	4



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

8 November 2000

Date of mailing of the international search report

10 -11- 2000

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/DK 00/00435

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 8297859 A (SONY DISK TECHNOLOGY KK) 1996-11-12 (abstract) World Patents Index (online), London, U.K.: Derwent Publication, Ltd. (retrieved on 2000-11-07). Retrieved from: EPO WPI Database, DW199704, Accession No. 1977-039904 JP 8297859 A (SONY DISC TECHNOL: KK) 1997-03-31 (abstract). (online) (retrieved on 2000-11-07). Retrieved from: EPO PAJ Database.	1,5,9
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Y	IEEE Transactions on Consumer Electronics,, Volume 44, No 3, August 1998, Masato Yamada et al, "DVD/CD/CD-R COMPATIBLE PICK-UP WITH TWO-WAVELENGTH TWO-BEAM LASER" page 591 - page 600 -----	8

INTERNATIONAL SEARCH REPORT

Information on patent family members

03/10/00

International application No.

PCT/DK 00/00435

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				JP	8161771	A	21/06/96
				JP	8212597	A	20/08/96
				US	5876823	A	02/03/99
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